Estuarine Habitat Mapping and Classification System Manual

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ESTUARINE HABITAT MAPPING AND CLASSIFICATION SYSTEM MANUAL

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Beautiful British Columbia Magazine

1. INTRODUCTION

In recent years the value of British Columbia's estuarine resources has gained increased recognition by both government and the general public. One result of this increased recognition was the establishment in 1979 of a separate Coastal and Estuary Program* within the Ministry of Environment. The goal of that program was "to develop and implement a program which promotes the sensitive and orderly planning, assessment and management of British Columbia's coastal and estuarine environments in the long-term, based on an understanding of the natural attributes of these environments." Furthermore, one of the major objectives of the Coastal and Estuary Program was "to develop and set procedures and standards for data collection and analysis of coastal and estuarine habitats". This manual is intended to address that objective for estuarine fish and wildlife habitat. In it are outlined the philosophy and data collection and mapping procedures developed for the Terrestrial Studies Branch's Estuarine Habitat Mapping and Classification System. It is intended to provide standards to ensure consistency among mappers and to familiarize users with the terminology employed in estuary habitat inventory and mapping. Whenever possible terminology has been adopted from other systems without change. A list of sources of terminology used in this manual is found in Appendix 1.

The mapping and classification system described here is intended to provide biophysical information in a systematically mapped form to assist regional land planners, fisheries and wildlife managers and other coastal resource information users in making informed decisions regarding estuarine environments. This methodology and classification system is a refinement and synthesis of estuary classification approaches initiated within federal and provincial government agencies during the last ten years.

* Recently this program was combined with the Terrestrial Studies Program to form the Planning Assessment and Inventory Standards Program.

Initially estuarine habitat classifications concentrated on vegetation type descriptions eg. Forbes (1972) and Yamanaka (1975). In 1974 a preliminary estuarine habitat mapping program, based on existing 20 to 40 chain black and white aerial photography, was conducted on Vancouver Island. Several reports were prepared from this work. (For example, see Kennedy and Waters (1974)). To facilitate more detailed interpretations of estuarine plant communities and substrates, the Fish and Wildlife Branch Habitat Protection Section began in 1975 to order large scale (1:5 000 - 1:10 000) colour and colour I.R. aerial photos of priority estuaries in all coastal Regions. In 1976 the Department of Fisheries and Oceans initiated a computerized resource (including foreshore vegetation) and land use mapping approach (Wayne et al.,1980) and more recently the Canadian Wildlife Service (Pacific and Yukon Region) has developed methods for assessing estuarine vegetation involving transect sampling and subsequent computer analysis (Dawe and White, in press).

The basis for a more comprehensive aporoach to estuary habitat mapping was laid by the Estuary Working Group which produced a number of reports on the major estuaries of the province. The first of these was completed for the Fraser River (Hoos and Packman, 1974). Later, physical aspects of the habitat were introduced to vegetation community descriptions. As a result of needs identified by the Squamish Task Force, subsequent efforts of the Fraser River Estuary Task Force permitted further refinement of the methodology as presented here.

Users of coastal resource information should attempt to make themselves aware of other complementary coastal inventory systems available from the Terrestrial Studies Branch. These are:

1) The Physical Shorezone and Process Inventory System - which includes a physically oriented estuary mapping component and
2) The Coastal Waterbird Inventory System.

Manuals describing these are expected to be available during winter 1982-83.

2. THE INVENTORY PROCESS

The estuarine habitat mapping and classification system facilitates collection, organization and presentation of information describing biophysical characteristics of estuaries considered important to fish and wildlife species. The fundamental unit within the classification system is the habitat type. Not to be confused with those of Daubenmire, estuarine habitat types are based on tidal zonation and biophysical habitat components modified by appropriate substrate, vegetation, salinity and anthropogenic descriptors (see Table 1 and Appendix 3). Because the habitat modifiers cannot always be assessed remotely, considerable field work is required in addition to airphoto interpretation.

2.1 DATA COLLECTION

Prior to initiation of data collection a study area boundary should be defined and the most appropriate scale of presentation determined. Study area boundaries are normally arrived at through consultation with the requestor and include all or most of the intertidal portion of the estuary and contiguous subtidal and backshore areas. The usual mapping scale is 1:5 000 - 1:10 000. Every effort should be made to ensure that the final product will serve the needs of a broad audience and not solely those of the requestor. The data collection process consists of two phases; (i) pretyping of aerial photos and review of existing information and (ii) field surveys.

Pretyping and Review of Existing Information

Since 1975, low tide, mid summer, large scale (1:4800 - 1:12 000) colour aerial photographs have been taken of most of the major estuaries in the province by the Surveys and Mapping Branch, BCMOE. Prior to entering the field, those and any additional aerial photographs along with marine charts and any other pertinent resource mapping are used to pretype the study area. Vegetative and physical boundaries should be established during

pretyping. Pretyping involves initial delineation of homogeneous areas based on vegetative and/or physical attributes determined from aerial photographs. Specific patterns of colour, tone, texture and shape have been found to represent homogeneous habitat types within individual estuaries.

Because no large scale terrain mapping exists for coastal areas/ estuaries, whenever possible a fluvial geomorphologist should be consulted during the pretyping phase to confirm physical boundaries that are established.

The importance of pretyping cannot be overstated. Pretyping provides relevant information to study area logistics such as access, boat and time requirements. Pretyping also aids in sample site selection and identification of problem areas which will require special attention.

Review of historical information involves gathering and examining airphotos, reports and inventory data for the study area. Examining aerial photography history permits an assessment of the relative stability of the area. This procedure also facilitates the investigation of the influence of human-caused impacts on the estuary and may assist in explaining conditions that are difficult to interpret in the field.

Agencies to be contacted when searching for reports and historical information include the Regional Fish and Wildlife Branch office, Marine Resources Branch, Aquatic Studies Branch, Terrestrial Studies Branch; Department of Fisheries and Oceans, Lands Directorate Pacific Region, the Canadian Wildlife Service and where appropriate, Public Works Canada. Land statusing should be checked through the Land Management Branch and Ministry of Lands, Parks and Housing. Land owners should be consulted prior to initiating field work.

2.1.1 ESTUARY SAMPLING

Field work should be conducted during the lowest tides of July and August. Ideally sampling activities should take place as close as possible

to the dates on the aerial photographs being used for the survey, but late enough in the growing season for grasses to have flowered. A recommended list of field equipment is provided in Appendix 2.

2.1.2 FIELD DATA COLLECTION

Sample sites should be established by pretyping large scale colour and, if possible, false colour IR airphotos. Standard TSB "Site Forms" should be filled out (See Appendix 2.1). Although those forms were not designed for estuarine areas, certain data elements in addition to general "header" information are of considerable value and are routinely recorded. These are indicated by X's on the Appended form. Additional information such as salinity, anthropogenic influence, fetch window, and prevailing wind direction can be recorded in the comments section of the Site Form. Special care is taken to locate and record the X and Y coordinates of each sample site to facilitate subsequent site relocation. Procedures for recording "Site" data are provided in Data Entry Procedures for Describing Ecosystems in the Field (Sondheim et al., 1982).

If a sample site supports vascular plants or macrophytic algae, a Vegetation Form (See Appendix 2.2) should be completed. Standard plot size should be 4 m x 4 m. Five sample plots per homogeneous pretyped habitat should be completed.

Procedures for recording vegetation data are provided in Data Entry Procedures for Describing Ecosystems in the Field (Sondheim et al., 1982). Unknown plants encountered should be assigned numbers and collected in triplicate at least for subsequent identification by plant taxonomists. All specimens, along with accompanying data, should be deposited at the British Columbia Provincial Museum.

Except for extremely large estuaries, one Wildlife Form (See Appendix 2.3) should suffice for an entire study area. Details of the correct procedure for recording wildlife data are provided in Data Entry Procedures for

Describing Ecosystems in the Field: Wildlife (Pendergast et al., 1982). All Terrestrial Studies Branch data forms are designed for computer entry without intermediate transcription.

While in the field, special attention should be paid to the location of habitat boundaries (boundaries indicating physical or vegetative changes of significance to wildlife or fish). Intertidal/Backshore and Intertidal/Subtidal boundaries may sometimes be particularly difficult to identify. To identify those boundaries field workers should determine the tide levels at which available aerial photographs were taken and extrapolate on the basis of indicator species and observation of known high and low tides while in the field.

Special attention should also be paid to features such as culverts, floodgates, outfalls, intakes, dykes and other anthropogenic features that may influence habitats.

3. DATA PRESENTATION

Data should normally be presented in the form of a map and descriptive or interpretive legend (see map of Tashish Estuary in envelope of back cover). Maps are available from the Maps-B.C., Surveys and Resource Mapping Branch, Parliament Buildings, Victoria. B.C., V8V 1X5, telephone: (604) 387-1441.

3.1 MAPPING AND MAP SYMBOLS

The normal scales of presentation of Estuarine Habitat Maps are 1:5 000 and 1:10 000. Habitat zones and component modifiers that are mapped are presented in Table 1. Zones represent areas which differ as a result of tidal influence. Components (zonal subdivisions) are generally biophysically homogeneous areas considered to represent different habitats.

Zone and component comprise the numerator of map symbols and indicate habitat types. These may be affected by various "habitat modifiers" such as substrates, vegetation, salinity, and anthropogenic features which occur in the denominator of each symbol. Each of the terms presented in Table 1 is described in Appendix 3. On site symbols are used to indicate selected anthropogenic features. Care has been taken to ensure that such symbols are as standardized as possible.

In order to ensure consistency between mappers, a list of mapping conventions has been created. These are presented below.

Estuary Habitat Mapping Conventions

1) Maps represent habitat types and features as they exist at the time of field work.

2) Zone and component boundaries represent approximations based on airphoto interpretation and field checking.

TABLE 1

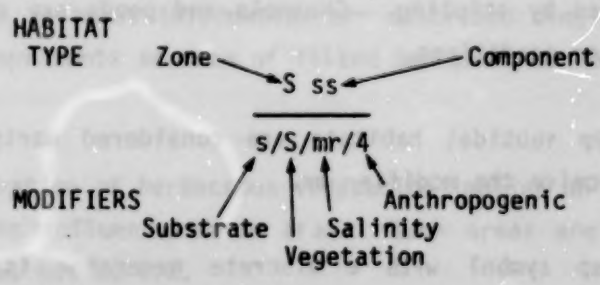
ESTUARINE HABITAT MAPPING AND CLASSIFICATION SYSTEM
HABITAT TYPES AND MODIFIERS

HABITAT TYPES				MODIFIERS	
ZONE	SYMBOL	COMPONENT	SYMBOL		SYMBOL
SUBTIDAL	S			SUBSTRATES	
		reef	re		
		deep subtidal	sd	clay	c
		shallow subtidal	ss	silt	ɡ
				fines	f
INTERTIDAL	I			sand	s
		bar	ba	small pebble	p
		berm/beach face	bf	large pebble	g
		cliff	cl	cobble	k
		back channel	cb	boulders	b
		river channel	cr	bedrock	r
		side channel	cs	organic	o
		tide channel	ct	shell	m
		flat	fl		
		marsh	ma	VEGETATION	
		high marsh	mh		
		intermediate marsh	mi	coniferous	C
		low marsh	ml	deciduous	D
		platform	pl	mixed	M
		reef	re	non-vascular	N
				submerged vascular	S
BACKSHORE	B				
		bar	ba	SALINITY	
		bog	bo		
		cliff	cl	brackish	br
		back channel	cb	fresh	fr
		river channel	cr	marine	mr
		side channel	cs		
		fen	fe	ANTHROPOGENIC	
		forest	fo		
		marsh	ma	log handling	1
		meadow	me	agriculture	2
		permanent pond	pp	landfill	3
		semi-permanent pond	ps	dyke, seawall,	4
		temporary pond	pt	causeway	
		shrub	sh	culvert	5
		storm ridge	sr	floodgate	6
		swamp	sw	outfall	7
				pollution	8
				intake	9
				residential	10
				industrial	11
				marina	12
				port facility	13
				substrate removal	14
				jetty, groin/groyne	15
				weir	
				log debris	16
				logged	17
				road	18

ANTHROPOGENIC ON-SITE SYMBOLS

bridge		rip rap	
jetty		culvert	⑤
dyke		floodgate	⑥
submarine cable		outfall	⑦
float/wharf		intake	⑧
ramp		study area boundary	

EXAMPLE OF A SYMBOL



3) Base maps are not necessarily updated to indicate the location of all cultural features. Where base maps must be created for a project only sufficient cultural features required for orientation are indicated.

4) Locations of each sample point labelled with the appropriate "site form" number are plotted on a separate reference map and stored by the Wildlife Unit.

5) Except in cases where map units are considered to be highly significant, units smaller than 1 cm^2 will not be indicated.

6) Substrate classification is based on the terminology and conventions utilized in the Terrain Classification System of the Terrain Section T.S.B (RAB, 1978).

7) Fifteen percent vegetative cover must be present if an area is to be included within a component which is defined on the basis of vegetation, e.g. marsh, meadow, shrub, forest.

8) Water bodies (i.e. deep subtidal, shallow subtidal, river channels, side channels, backchannels, tide channels and ponds) are indicated by stipling. Channels and ponds are usually mapped at low water conditions.

9) All deep subtidal habitats are considered marine and therefore will receive the modifier mr.

10) Each map symbol with a discrete numerator is described in a descriptive or interpretive legend. In addition, a separate description of anthropogenically dominated areas is presented for each unit having a discrete dominant anthropogenic modifier.

11) Two figures appear after each habitat type in the descriptive legend; one representing the total area of that habitat type in hectares and another representing the percentage of the total study area that each comprises.

12) Common names of vascular plants, mosses, lichens, liverworts, birds, fish and mammals appearing in descriptive or interpretive legends correspond to those used by Taylor and MacBryde 1977, Crum et al. 1973, Stotler and Crandall - Stotler 1977, A.O.U. Checklist 1957, Hart 1973, and Banfield 1974, respectively.

13) Generic names will be used for algae and invertebrates in accord with Scagel 1972 and Smith and Carlton 1975.

14) Former intertidal areas which have acquired characteristics of backshore areas are classified as Backshore.

15) Anthropogenic modifiers are attached to only those units affected directly by the anthropogenic influence.

16) Backshore areas where an anthropogenic feature has become an overriding factor such that the component and its modifiers provide little relevant information are described simply as B/Anth., e.g. B/3 represents an area of filled Backshore or Backshore created by fill.

17) Cultivation of herbaceous vegetation implies an overriding anthropogenic influence on an area. Such areas are not classified as meadows but as B/2.

18) If grazing by domestic animals occurs on backshore meadows the symbol Bme/2 applies.

19) Where the anthropogenic modifier for grazing (2) appears in the intertidal zone it refers to grazing by domestic livestock.

20) Up to three anthropogenic modifiers may be listed. These should occur in descending order of importance.

21) Numbers indicated on onsite symbols refer to anthropogenic modifiers, e.g. the symbol 6 represents the onsite symbol for floodgate.

22) Where areas such as causeways and dykes are sufficiently large, they are indicated as polygons and receive a symbol including the appropriate anthropogenic modifier.

23) Bars of the dyke onsite symbol occur on the landward side of the structure.

24) Where rip rap armors a linear structure the rip rap symbol should be present. If both sides of a structure are rip rapped the symbol should appear on both sides of the structure.

3.2 DESCRIPTIVE AND INTERPRETIVE LEGENDS

Habitat type information is presented in one of two legend formats which accompany each map. Descriptive legends consist of a characterization of each habitat type with a discrete numerator. "Ifl" (intertidal flats) for example, is a discrete map symbol numerator which could have several different denominators on the same map reflecting differences in substrates, salinity, presence or absence of nonvascular plants and various influences of anthropogenic features. The description of the "Ifl" habitat type would therefore indicate such variations for a given study area. Habitat type descriptions should incorporate existing information with field data to provide as complete a description as possible. Emphasis is placed on describing Intertidal and Subtidal habitat types. Backshore areas except where especially significant, are described only briefly.

Interpretive legends also describe habitat types and provide information on the value of individual habitat types to selected fish and wildlife species. Interpretive legends are generally structured to suit the needs of the requestor and may include detailed information on the effects of existing impacts or proposed developments on estuarine habitats. Rehabilitation and enhancement techniques for modified habitat types and disturbance sensitivity analysis may also be presented.

3.3 AREA DETERMINATIONS

Two figures appear immediately opposite the heading for each habitat type described in the legend; one representing the total area in hectares occupied by the particular habitat type and another representing the percentage of the total study area that each comprises.

Currently the hardware utilized for digitizing is a Hewlett-Packard 9825A calculator with a 9864A digitizing table. Programs are stored on cassette tape. A detailed digitizing procedure manual is available for all programs (British Columbia Systems Corporation, 1980, Digitizing Program Users Guide).

4. DATA MANAGEMENT AND ANALYSIS

As noted earlier, all site, soil, vegetation and wildlife data are collected on standardized computer compatible forms. Such data are entered into computerized data bases. Computer systems have or are being developed around those data bases using the site form Series and Number as a common thread. Those systems provide the capability for standard analytical procedures.

Although at present, vegetation data cannot easily be combined with site and soils information for computerized analysis, a computer program package (COENOS) is available to assist in computerized grouping of vegetative data. Because the environmental constraints on vegetation in estuaries are so severe, vegetative communities are generally quite discrete and data can easily be organized manually. In areas where vegetative patterns are more complex, however, computerized sorting packages should be utilized.

Present development of a computerized system called the Coastal Resource Information System (CRIS) is under consideration. Such a system would be based on the physical (terrain) and biological attributes of coastal environments. Links would be established between CRIS and the Ministry of Environment's site, soil, vegetation, wildlife and aquatics data bases.

5. RESEARCH NEEDS

The Estuarine Habitat Mapping and Classification System is still evolving, particularly in the area of interpretations. This unfinalized nature stems from both a lack of knowledge in certain subject areas and difficulties in applying available knowledge. Several research needs can be identified and they generally fall into two categories:

1) determination of the relative importance of specific habitat types to shellfish, fish, wildlife, and commercial plant species, and
2) identification of the physical characteristics that govern the distribution of faunal and floral components of habitats.

Increased knowledge in both areas is essential if those involved in coastal resource inventory are to improve the quality of interpretations regarding estuarine habitat for assessment, management and planning activities. The first step toward this "increased knowledge" must involve increased communication between agencies and individuals involved in coastal activities so that data gaps and data needs can be identified.

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APPENDIX 1

SOURCES OF ESTUARINE HABITAT MAPPING AND CLASSIFICATION TERMINOLOGY

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APPENDIX 2

ESTUARINE HABITAT SAMPLING EQUIPMENT LIST

Tide tables
Marine charts
Air photos and weatherproof envelopes
Clipboard (8 1/2 x 14)
Site forms
Soil forms
Wildlife forms
Vegetation forms
Manual (Describing Ecosystems in the Field)
Cruisers vest
Field guides
Pencils (lead and grease)
Salinity or Conductivity meter and backup
Shovel
Soil corer
Plastic bags
Plant press
Binoculars
Camera and film
(Inflatable) boat, motor and oars
Safety equipment
First aid equipment
Specialized gear as required, e.g. surveyors equipment

front

A00S00 **SERIES 82 FORM** **08454** **SITE DESCRIPTION FORM** Parameters which must be filled are circled. PAGE ___ OF ___

A00S01 Proj. ID. | 2. Plot No. | Date (Y/M/D) | NTS Sheet | 5. Lat. ° ' " | Long. ° ' " | 6. UTM System | Zone | Easting | Northing

A00S02 Location | Co-ord. | Flight line | Photo # | X | Y | Aspect | Slope % | Elevation : metres

A00S03 12. Terrain Yr. | Texture | Gen. Mat. | Qual. Desc. | Surface Express | Mod. Proc. | Qual. Desc. | 13. Phys. Sub. | 14. Zone/Subzone System | BGC V P | 15. Ecological Classification System | BGC Assoc. S | BGC Type P

A00S04 16. Vegetative Cover System | 1 g s v | 2 g s v | 3 g s v | 4 g s v

A00S05 17. Soil Classif. | Yr 19 | Phase | 1 2 3 | Family Particle Size 1 2

A00S06 18. Plot representing

25. Site position diagram (refer to Series No.)

A00S07

16 Site position macro
a. apex
b. face
c. upper slope
d. middle slope
e. lower slope
f. valley floor
g. plain

17 Site position meso
a. crest
b. upper slope
c. middle slope
d. lower slope
e. toe
f. depression
g. level

18 Site surface shape
a. concave
b. convex
c. straight.

19 Microtopography
a. smooth
b. micro mounded
c. slightly mounded
d. moderately mounded
e. strongly mounded
f. severely mounded
g. extremely mounded
h. ultra mounded

23. Meso slope length M

24. Meso up-slope length M

photo roll no. ___ photo no. ___ Direction

scale 1 : ___

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ENV. 1060

(back)

Exposure Type (allow 3)
a. not applicable
b. wind
c. insolation
d. frost
e. cold air drainage
f. saltspray
g. atmospheric toxicity

other

Comments:

27. Ecological Moisture Regime
a. very xeric
b. xeric
c. subxeric
d. submesic
e. mesic
f. subhygric
g. hygric
h. subhydric
i. hydric

28. Nutrient Regime
a. oligotrophic
b. submesotrophic
c. mesotrophic
d. permesotrophic
e. eutrophic
f. hypereutrophic

29. Soil Temperature Class
a. extremely cold
b. very cold
c. cold
d. cool
e. mild

30. Soil Moisture Subclass
a. xeric
b. arid
c. subarid
d. semiarid
e. subhumid
f. humid
g. perhumid
h. subaquic
i. aquic
j. per aquic

31. Soil drainage
a. rapidly
b. well
c. mod. well
d. imperfectly
e. poorly
f. very poorly

32. Perviousness
a. rapidly
b. moderately
c. slowly

33. Free Water
a. present
b. absent

34. Flood hazard
a. frequent and irregular
b. frequent
c. may be expected
d. rare
e. no hazard

A00508 35. Depth to (cm)
a. water table
b. rooting (effective)
c. root restricting layer
d. frozen layer
e. bedrock
f. carbonate
g. salinity

36. Bedrock type

37. Bedrock structure

38. Coarse fragment lithology type (in order of dominance)

if mixed (enter '1')

00509 39. Successional Status
Present Stage: PS, YS, MS, OS, YEC, YCC, MCC, MEC, DC, NV

Expected climax

Rate of succession
a. very slow
b. slow
c. normal
d. rapid
e. very rapid

40. Factors Influencing Stand Establishment

00510 41. Veg. Plot: Area (ha) Shape # Dimensions X x Y (m)

42. Humus Form Class. Variants

43. Surface Substrate

SUBSTRATE	% COVER
Decaying Wood	
Bedrock	
Cobbles and Stones	
Mineral Soil	
Organic Matter	
Water	
Total	100%

44. Profile Status
a. modal
b. variant
c. taxadjunct
d. undecided

45. Profile Deviation (allow 3)
a. none
b. solum thickness
c. colour
d. texture
e. drainage
f. chemical
g. horizon thickness
other:

46. Soil Mapping Unit
a. series
b. family
c. associate
d. association
e. catena
f. complex
g. land system
h. land type
z. other

00511 47. Soil name

48. Associated soil

Project Coordinator

Surveyor

49. Profile No.

Agency

Type of Soil Sample

Chemical	Physical
a. full	a. full
b. partial	b. partial

53. Sampling Tech.

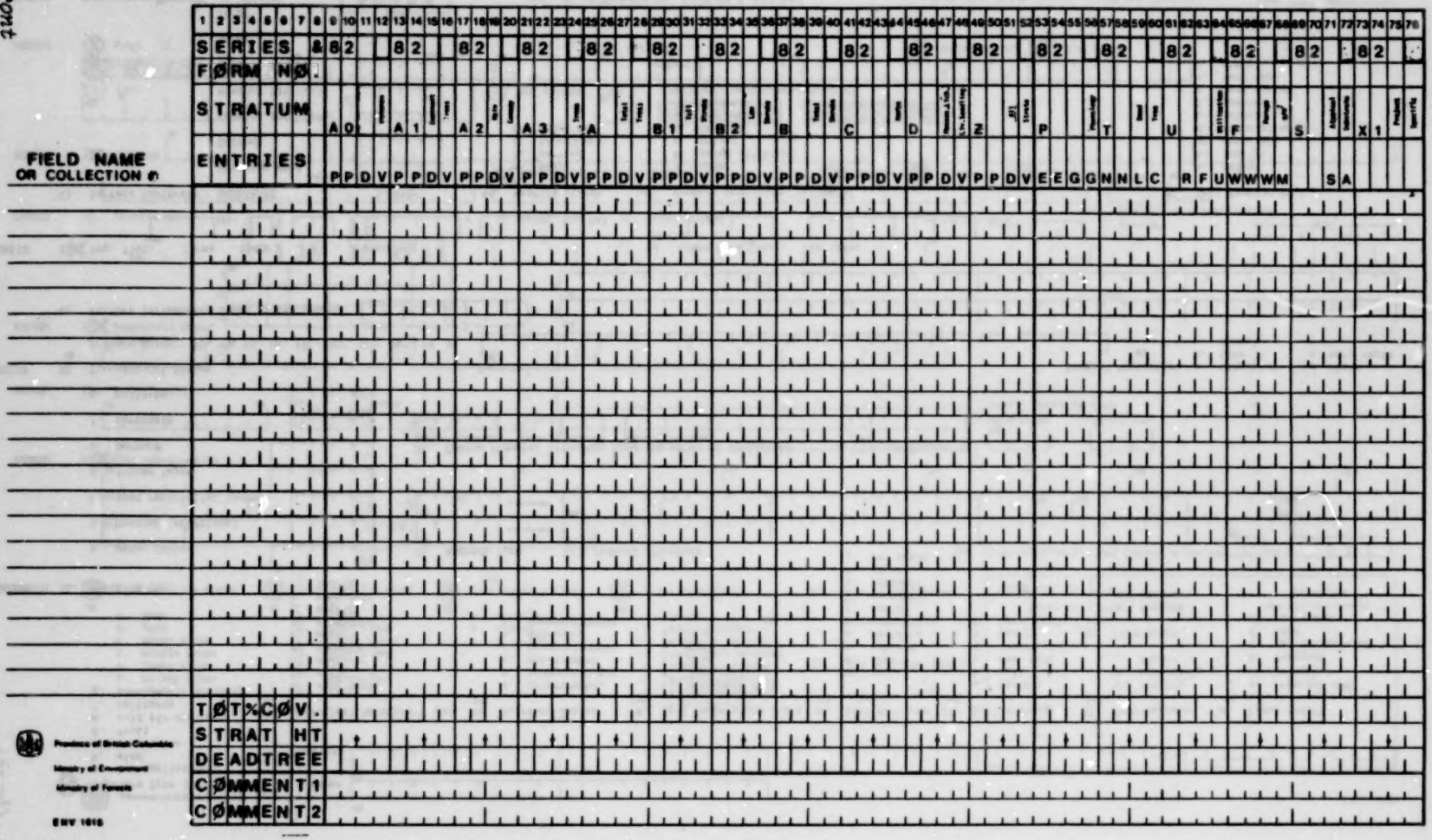
APPENDIX 2.2

TERRESTRIAL STUDIES BRANCH VEGETATION DATA FORM

front

VEGETATION DESCRIPTION FORM

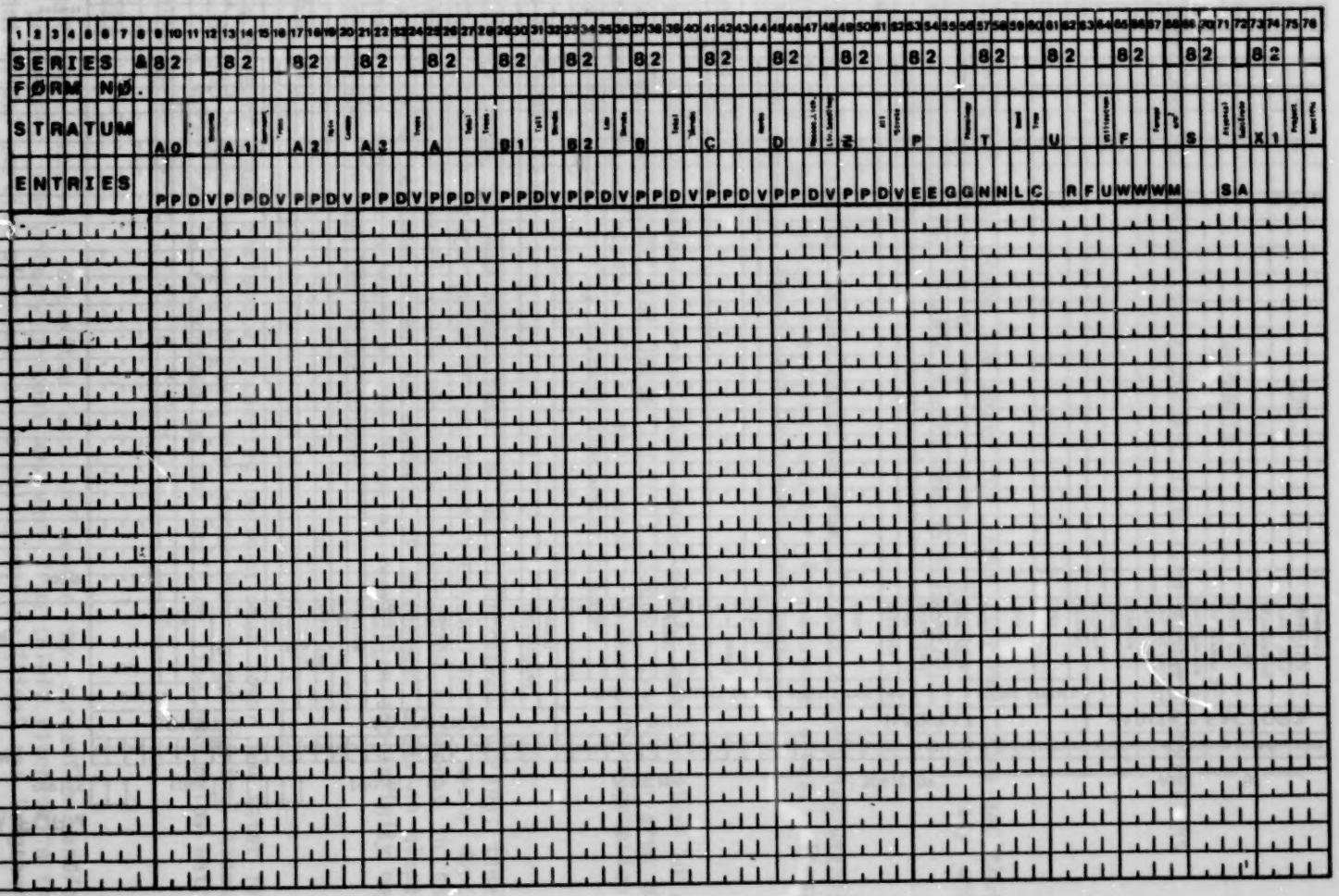
PROJECT ID. _____ PLOT NO. _____ SURVEYOR _____ PAGE ___ OF ___



Province of British Columbia
Ministry of Environment
Ministry of Forests
ENV 1010

(back)

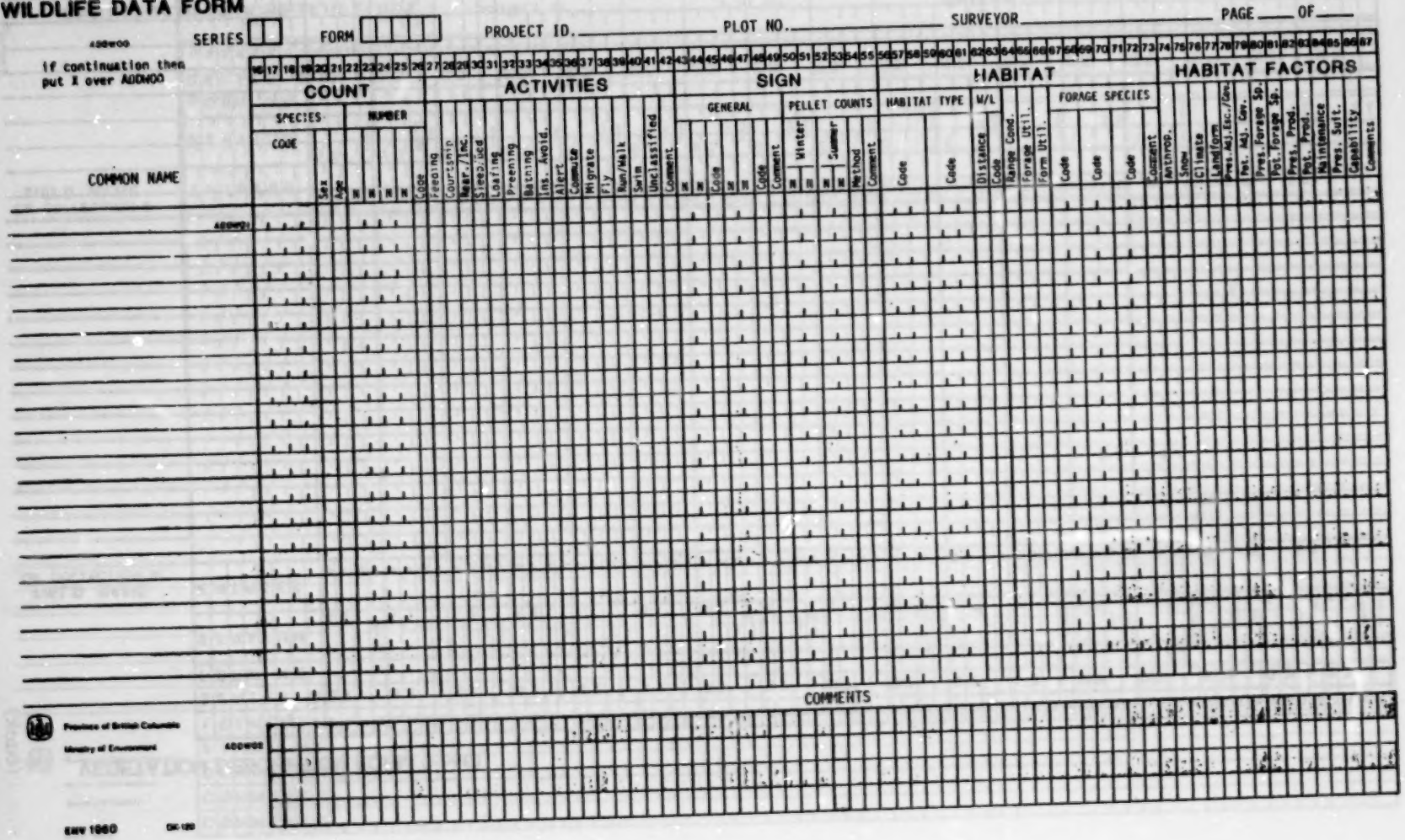
VEGETATION DESCRIPTION FORM (cont.)



FIELD NAME OR COLLECTION #

APPENDIX 2.3

TERRESTRIAL STUDIES BRANCH WILDLIFE DATA FORM



APPENDIX 3

ESTUARINE HABITAT MAPPING AND CLASSIFICATION TERMINOLOGY DESCRIPTIONS

HABITAT TYPES

SUBTIDAL (S)

The area below mean lower low water for large (spring) tides and thus usually covered by brackish or marine water. Substrates may vary and submergent and/or floating aquatic plants may be present.

Reef (re)

A ridge, small island, island chain or area of rocks originating within the subtidal zone and often providing shelter for inshore areas. These generally do not posess a significant backshore component.

Deep Subtidal (sd)

Marine process dominated areas with water depths greater than 10 m below mean lower low water for large (spring) tides. Usually an area of fine sediment accumulations which may support submergent vegetation. Salinity may vary considerably through the water column.

Shallow Subtidal (ss)

Offshore areas between mean lower low water for large (spring) tides and 10 metre water depth relative to these tides. The 10 metre depth approximates the basinward limit of coarse river-borne sediments in the majority of estuaries and often corresponds to an abrupt break in slope. These areas may support submergent and floating vegetation and salinity may vary considerably through the water column.

INTERTIDAL (I)

The area of tidal influence occurring between mean lower low water for large (spring) tides and mean higher high water for large (spring) tides. Higher high water can be recognized as the driftlog line and below which woody vegetation does not usually occur.

Bars (ba)

Surficial materials deposited and influenced by streamflow and/or marine processes. The primary process may vary from solely riverine in the upper intertidal portion of estuaries to solely marine (tidal and longshore drift) in non-intertidal areas.

Beach Face/Berm (bf)

An accumulation of unconsolidated materials within the upper intertidal zone at about the mean higher high water line for large (spring) tides of a beach. These are often ephemeral and of variable width. The berm is usually flat (although it may slope gently landwards) while the beach face normally slopes gently seawards. Annual plants may colonize such areas but permanent vegetation is rarely established.

Cliff (cl)

A uniform or irregular sloping face (>20° slope but more commonly >30°) made up of bedrock or unconsolidated materials or both. These are usually formed by erosional processes.

Backchannel (cb)

A dead-ended side channel (see Side Channel).

River Channel (cr)

An area composed of a bed and banks which regularly or intermittently serve to confine water in a single or multiple thread. Depth and current may vary considerably in relation to season and tide. Emergent and/or submergent vegetation may be present. River channels are formed by fluvial processes which distinguishes them from tide channels.

Side Channel (cs)

Channel formed by fluvial processes and connected to the main river or stream. Current velocities and depth may vary considerably in relation to season and tide, however, the major influencing factors are riverine. Emergent and/or submergent vegetation may be present.

Tide Channel (ct)

Channel resulting from and dominated by tidal processes. These drain the intertidal portion of the delta and are often characterized by silty organic bed materials and steep banks. Emergent and submergent vegetation is often present.

Flat (fl)

Low gradient intertidal components which do not support significant (15%) vascular vegetation. These often support diverse macro and micro, drift and attached algae. Bars and troughs may be present in some situations.

Marsh (ma)

A generally low gradient area which supports significant (15%) non woody vascular vegetation for at least part of the year and is characterized by a surface accumulation of organic material deposited in water. Three types of marsh commonly exist within the intertidal zone.

High Marsh (mh)

An intertidal marsh covered by most high tides. Some soil development and organic buildup is obvious. Such areas often exhibit a high diversity of plant species dominated by grasses and forbes, e.g., Pacific small reed grass; creeping bent grass; marsh peavine; and parsley family members. The upper portion of the high marsh may be bounded by a berm/beach face, storm ridge, shrub carr, or forest.

Intermediate Marsh (mi)

An intertidal marsh covered by all high tides and some moderate tides. Such areas are transitional in nature with regard to plant species diversity and soil development. They are usually dominated by grasses, sedges, and rushes.

Low Marsh (ml)

An intertidal marsh exposed at low tides and covered at most moderate and all high tides. Such areas are characterized by: little or no soil development; low species diversity; hydrophyllic and often halophytic pioneer species; and often discontinuous cover. Commonly dominated by sedges, glasswort, sea-milkwort, and/or sea plantain.

Platform (pl)

A level or low gradient surface (<20°) composed of bedrock or glacially compacted materials which may be overlain by a thin veneer of beach sediments.

Reef (re)

A ridge, small island or island chain originating in the intertidal zone often providing shelter for inshore areas and generally not possessing a significant backshore component.

BACKSHORE (B)

Portion of the shore zone above the mean higher high water for large (spring) tides (i.e., above the effective level of tidal influence) where processes are predominately riverine in nature. The sediments usually feature soil development and organic buildup. The majority of the upland areas are never inundated; however, lower areas may be inundated as a result of exceptionally high tides, tidal damming and/or freshet conditions.

Bars (ba)

Bed materials deposited by streamflow within the stream channel. These differ from intertidal bars in that riverine processes are the only operative factors.

Bog (bo)

A rain-fed wetland comprised of in situ accumulations of poorly to moderately decomposed Sphagnum derived peats. Bogs are generally very acidic and low in mineral materials. Sphagnum mosses generally comprise the dominant cover. Common bog shrubs are common Labrador tea and bog blueberry (Equivalent to Ministry of Environment vegetation map symbol wb).

Cliff (cl)

(see Intertidal section)

Backchannel (cb)

(see Intertidal section)

River channel (cr)

(see Intertidal section)

Side channel (cs)

(see Intertidal section)

Fen (fe)

A relatively mineral rich groundwater-fed wetland comprised of in situ accumulations of well to poorly decomposed sedge derived peats. Vegetation may be dominated by sedges, shrubs, and mosses. (Equivalent to Ministry of Environment vegetation map symbol wf).

Forest (fo)

An area within which tree life forms 10 metres or greater comprise the dominant cover. May be found on fluvial, marine, till, and bedrock/colluvial derived sites.

Marsh (ma)

(see Intertidal section). Note that due to restricted tidal influence only the general definition applies. (Equivalent to Ministry of Environment vegetation map symbol wm).

Meadow (me)

A periodically saturated but infrequently inundated herbaceous area developed on a mineral soil. These are grass and/or herb dominated areas with variable sedge and rush components. (Equivalent to Ministry of Environment vegetation map symbol m).

Permanent Pond (pp)

A natural or artificial body of permanent standing water generally less than 2 hectares in surface area.

Semipermanent Pond (ps)

A pond which occasionally dries due to insufficient runoff or drought conditions.

Temporary Pond (pt)

A pond which annually dries by mid summer.

Shrub Carr (sh)

A periodically saturated but rarely inundated shrub dominated area developed on mineral soils. Typical shrub species are Pacific crab apple, roses and red alder.

Storm Ridge (sr)

An elevated hillock-like area of unconsolidated materials deposited above higher high water usually resulting from longshore or onshore drift. These units are characteristically well drained and littered with drift logs. Typical plant species are: wild rye grass, roses, currants, entire-leaved gumweed, and yarrow.

Swamp (sw)

A wetland primarily influenced by freshwater (usually riverine) and characterized by a surface accumulation of organic material deposited in water. These are dominated by shrubs or trees and often have permanent subsurface water flow and periodic flooding. (Equivalent to Ministry of Environment vegetation map symbol ws). Typical shrub species are willows.

HABITAT MODIFIERS

1) Surficial Materials

Surficial materials are described below by texture class as applicable.

Materials	Class
Clay (c)	less than .004 mm
Silt (ȿ)	.004 - .062 mm
Sand (s)	.062 - 2.0
Small Pebble (p)	2.0 - 16 mm
Large Pebble (g)	16 - 64 mm
Cobble (k)	64 - 256 mm
Boulders (b)	greater than 256 mm
Fines (f)	a mixture of silt & clay, may also contain a fraction of fine sand.
Bedrock (r)	exposed solid rock.
Organic (o)	surface material comprised of greater than 30% organic matter by weight.
Shell (m)	an accumulation of waste shells and shell fragments.

2) Vegetation

Vegetation modifiers are used in conjunction with forest and shrub habitats or components which do not consistently support vegetation, e.g. bars, flats and certain anthropogenically influenced backshore units. Components which are defined on the basis of herbaceous vegetation such as meadows or marshes do not require modifiers.

Submergent Vascular (S)

Vascular vegetation which is rooted in materials covered permanently by water and whose principle photosynthetic surfaces are commonly submersed or floating at the water surface, e.g. eel-grass and ditch-grass.

Non-Vascular (N)

Plant life which does not possess a specialized cellular system for conducting water and nutrients. This modifier includes macrophytic algae only such as Fucus spp., Nereocystis luetkeana, Ulva spp. and Enteromorpha spp.

Coniferous (C)

Predominantly trees or shrubs bearing needle-like leaves. Cone-bearing trees such as Douglas-fir, Sitka spruce and western red cedar are examples.

Broad-leaved (D)

Trees and shrubs with broad leaves which are generally shed in the fall. Cones are not produced. Examples are maple, crab apple, Pacific madrone and cottonwood.

Mixed (M)

Forest vegetation which is dominated by a combination of greater than 10% coniferous and greater than 10% deciduous trees and shrubs.

3) Salinity

Salinity is an expression of the concentration of inorganic salts dissolved in seawater. Because salinity relationships within estuaries are very complex and are affected by a number of factors; the modifier is used only to give a general indication of the surface salinity of the inundating water during the summer months.

Fresh (fr)

Water which contains less than 0.5 ppt dissolved inorganic salts.

Brackish (br)

Water which contains between 0.5 and 18 ppt dissolved inorganic salts.

Marine (mr)

Water which contains greater than 18 ppt inorganic salts.

ANTHROPOGENIC

Anthropogenic modifiers are used where man's activities have affected or altered estuary habitats.

log handling (1)	included in this category are log booming, storage, dumping and haulout areas.
agriculture (2)	lands which have been modified due to agricultural activities such as grazing and cultivation.
landfill(3)	unconsolidated materials including dredge spoil deposited within low lying areas for purposes of upland development or disposal.
dyke, seawall, causeway (4)	artificial wall or embankment constructed to prevent flooding and/or erosion or to allow passage over wet ground.

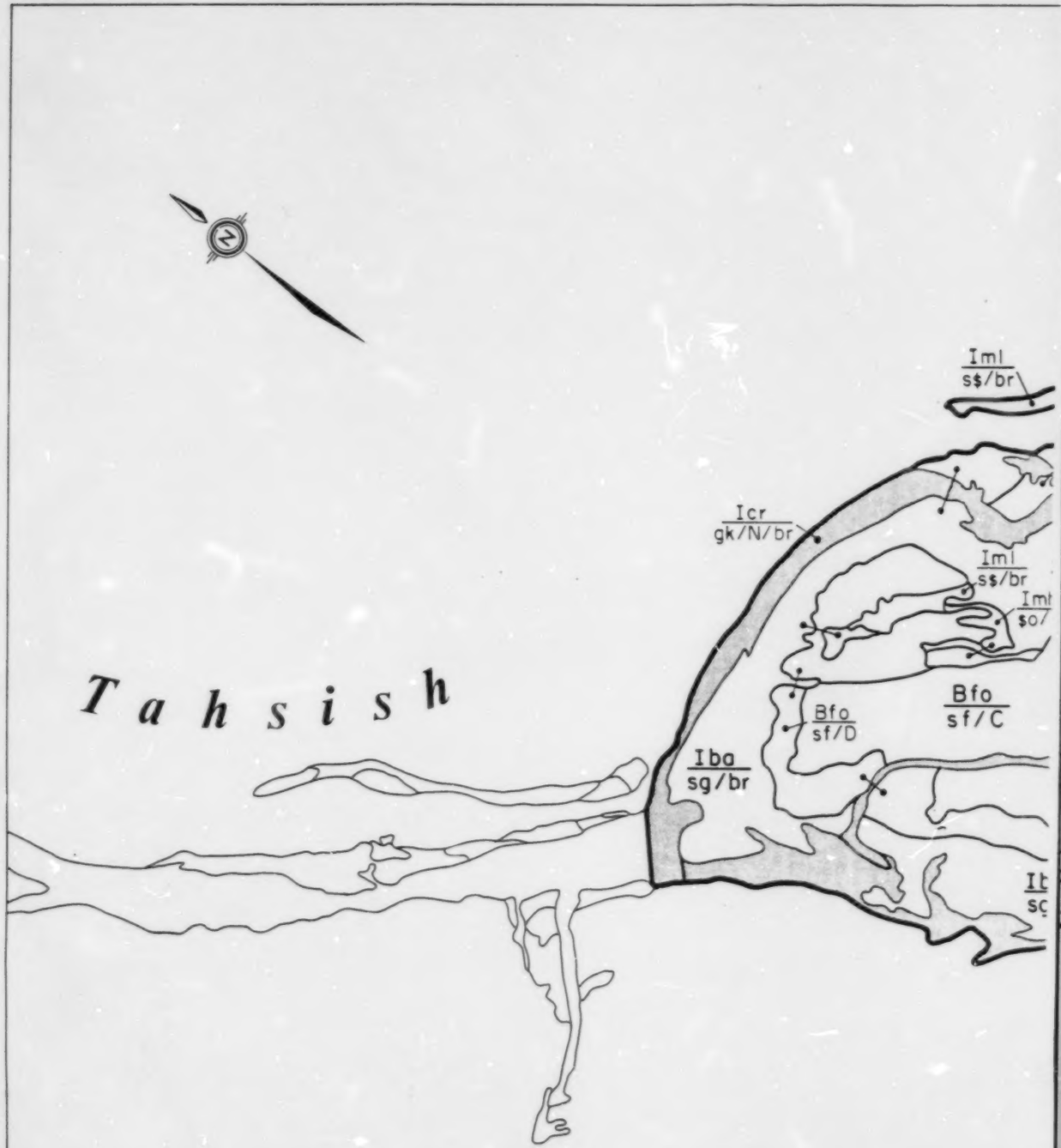
culvert (5)	an open-ended transverse drainage structure. These often underlie a road, railway, dyke or embankment.
floodgate (6)	a structure designed to control the flow of water between the intertidal and backshore. These may be associated with a pump house.
outfall (7)	drain or pipe from which effluent is discharged into water.
pollution (8)	includes sites for treating and disposal of industrial and domestic wastes, toxic chemicals and other pollutants. e.g. sewage treatment plants.
intake (9)	a pipe by which water is taken in for industrial or other uses.
residential (10)	includes areas having dwellings for human habitation and adjacent lands obviously asssociated with these dwellings such as yards and gardens.
industrial (11)	includes commercial, manufacturing, raw material processing, and mining sites.
marina (12)	a dock or series of docks, usually in a protected location that provides secure moorings for motorboats and yachts, as well as offering supplies, repairs and other facilities.
port facility (13)	a terminal and related structures extending from the backshore to subtidal waters and serving as a cargo onloading/offloading area for large ships. These areas may include docks, storage yards, parking lots and buildings.
substrate removal (14)	an area of intertidal or subtidal habitat, such as a dredge channel, or which has been deepened as a result of mechanical removal of bottom sediments.
jetty, groin/groyne, weir (15)	includes training structures and breakwaters extending into the sea, found within a channel or constructed perpendicular to the shoreline for the purpose of channelizing and directing stream or tidal flows, preventing channel shoaling by littoral materials or retarding shoreline erosion by trapping littoral drift.

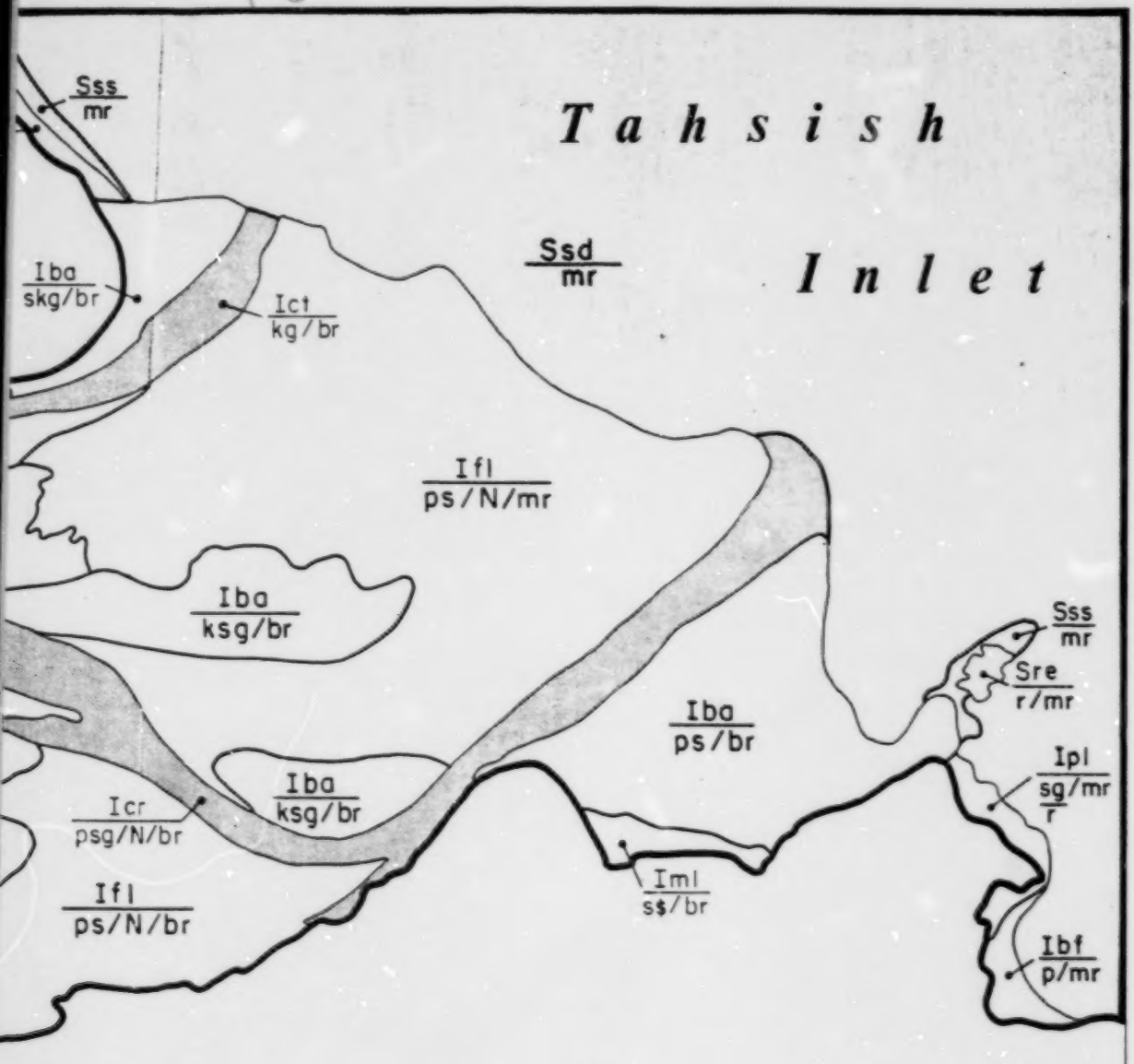
log debris (16)	includes deposits of organic materials such as bark, wood slabs, stumps, limbs and drift logs derived from forestry related activities.
logged (17)	areas of active or recent timber harvesting.
road (18)	paved and unpaved thoroughfares and access roads. Associated parking areas are also included.

1-A

TAHSISH ESTUARINE HABITAT INVENTORY

1-B



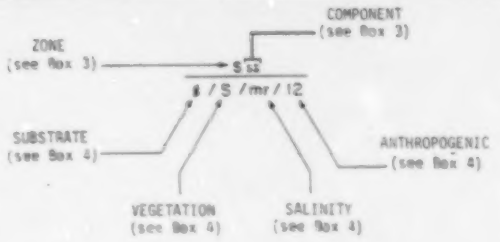


Scale approximately 1:5000

1. Explanatory Notes

The estuarine habitat mapping and classification system is designed to delineate habitat types and describe them as a function of substrate, vegetation, salinity and anthropogenic influences. Information is derived from interpretation of recent large scale colour air photos and ground truthing, and is supplemented by information derived from historical reports and air photos. Specific descriptions of habitat types are presented in Box 5 along with area summaries expressed in hectares and as percentages. Because of the dynamic nature of estuarine systems maps may require updating. Users should therefore refer to the date of mapping shown in Box 8. Users are encouraged to consult APD Technical Paper, Estuarine Habitat Mapping and Classification System Manual 1982, for descriptions of inventory and mapping methods and terminology utilized in the classification system.

2. Example of Map Unit



3. Habitat Type

ZONE	SYMBOL	COMPONENT	SYMBOL
SUBTIDAL	S	reef	re
		deep subtidal	sd
		shallow subtidal	ss
INTERTIDAL	I	bar	ba
		berm/beach face	bf
		back channel	cb
		river channel	cr
		side channel	cs
		tide channel	ct
		flat	fl
		marsh	ma
		high marsh	mh
		intermediate marsh	mi
		low marsh	ml
		platform	pl
		reef	re
BACKSHORE	B	bar	ba
		bog	bo
		back channel	cb
		river channel	cr
		side channel	cs
		fen	fe
		forest	fo
		marsh	ma
		meadow	me
		permanent pond	pp
		semi-permanent pond	ps
		temporary pond	pt
		shrub	sh
		storm ridge	sr
		swamp	sw

4. Habitat Modifier

TYPE	SYMBOL	TYPE	SYMBOL
SUBSTRATES		SALINITY	
clay	c	brackish	br
silt	si	fresh	fr
fines	f	marine	mr
sand	s		
small pebble	p		
large pebble	g		
cobble	k		
boulders	b		
bedrock	r		
organic	o		
shell	m		
VEGETATION		ANTHROPOGENIC	
coniferous	C	log handling	1
deciduous	D	agriculture	2
mixed	M	landfill	3
non-vascular	N	dyke, seawall, causeway	4
submerged vascular	S	culvert	5
		floodgate	6
		outfall	7
		pollution	8
		intake	9
		residential	10
		industrial	11
		marina	12
		port facility	13
		substrate removal	14
		jetty, groin, weir	15
		log debris	16
		logged	17

2-B

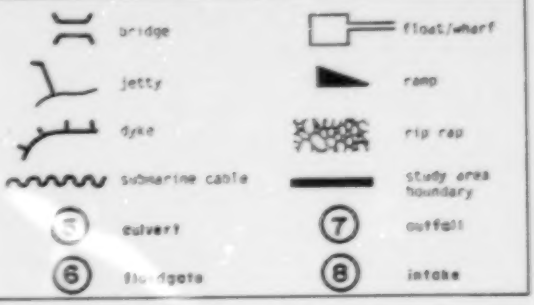
LEGEND

5. Descriptions of Habitat Types

SYMBOL	DESCRIPTION	AREA (ha)	% T.A.
	SUBTIDAL ZONE	35.9	24.8
Sre	This habitat type includes bedrock outcrops located within the subtidal zone. Supratidal portions are sparsely vegetated.	6.1	4.2
Ssd	Subtidal habitats with bottom depths greater than 10 metres. Less saline areas are found in the surface water layers. These areas support a variety of groundfish as well as providing habitat for salmonid staging. Bird use includes feeding and loafing by diving birds and loafing by dabbling ducks and gulls. Harbour seals utilize subtidal habitats for feeding.	29.7	20.5
Sss	Included in this habitat type are subtidal areas with depths less than 10 metres. Within this habitat type, brackish water overlies waters of higher salinity. Fish and wildlife use of this habitat type is similar to deep subtidal habitats except for higher utilization by diving ducks for feeding.	0.4	0.3
	INTERTIDAL ZONE	93.4	64.4
Ibe	Formed along the bends of the river channels, these active, depositional areas are generally composed of large pebbles with some sand and cobbles. Sediment transport and deposition patterns are dominated by fluvial factors with some modifications by marine processes. Filamentous green algae (Enteromorpha intestinalis) and rockweed (Fucus sp.) occur on bars near the mouth of the estuary. Stable bars commonly have minor amounts of vascular vegetation. Within the upper portion of the estuary these areas may serve as spawning habitat for pink and chum salmon. Bars serve as loafing sites for wintering and migrating waterfowl and shorebirds. Bald eagles and American black bear utilize river bars extensively during the fall salmon runs. Other mammals utilizing these habitat include American mink, river otter and raccoon. Bars located near the ocean may be utilized as harbour seal haulouts.	26.8	18.5
Ibf	This upper intertidal habitat type is characterized by pebble substrates. These marine dominated areas are generally unvegetated or sparsely vegetated by annual plants. Bird use is limited to feeding shorebirds and songbirds and loafing dabbling ducks, Canada geese and wintering seaducks. American mink, river otter and raccoon may make extensive use of these areas.	0.3	0.2
Icr	This habitat includes mainstem areas of the Tahsish River which are influenced by saltwater penetration and regular and seasonal fluctuations due to tidal and fluvial influences respectively. Bed materials vary from pebble/cobble within the upper portions of the delta to pebble/sand in the lower portion of the delta. Filamentous green algae occur along channel edges. This habitat type is important for salmonid migration, spawning and rearing. Wintering and migrating diving ducks and wintering trumpeter swans utilize river channel habitats for feeding and loafing. Mammalian use includes river otter, American mink and raccoon.	8.8	6.1
Ics	Two side channels are present within the study area. One has cobble bed materials and runs along the western boundary of the study area. Filamentous green algae occur along its channel edges. The other channel is wetted only during high tides or high river flows and has a finer textured bed of sand and large pebbles. These channels function as important migration spawning and rearing areas for salmonid species. Dabbling waterfowl utilize these areas to a limited extent for feeding migration and wintering. Mammalian use is similar to river channel habitats.	5.1	3.5
Ict	This habitat type consists of a large channel at the mouth of the estuary and numerous small channels and diverticulations which drain the intertidal marshes and flats. Most of these dry at low tide. Bed materials vary from cobble and pebbles in the larger channel to finer textured materials within the smaller channels. Low marsh plants, particularly Lyngbye's sedge border the channels. This habitat type is extremely important as a nursery area for juvenile salmonids. Dabbling ducks, trumpeter swans and wading birds utilize tidal channels for feeding during migratory and winter periods. These areas are also utilized by mink, river otter and raccoon.	1.0	0.7

SYMBOL	DESCRIPTION	AREA (ha)	% TOTAL
	INTERTIDAL ZONE (continued)		
Ifl	This habitat type is exposed only at low tides, and occurs adjacent to low marsh areas and intertidal bars. The flats are generally characterized by finer textures and lower gradients as compared to bars. Filamentous green algae, brown algae and to a lesser extent alkali grass are commonly present. Epibenthic diversity on the flats is low. This habitat type serves as a nursery area for juvenile salmonids and as a pre-spawning staging area. Other fish utilize flats for year-round foraging. Waterfowl use of intertidal flats includes feeding by migrating and wintering dabbling ducks, wintering trumpeter swans and migrating Canada geese. Shorebirds and waders also utilize flats for feeding. Migrating and wintering diving duck use may be extensive at high tide stages. Bald eagles and American black bear forage on flats for salmon carcasses during fall migration periods. Harbour seals may utilize specific areas as haulouts.	23.7	16.3
Inh	This habitat type is located between backshore forest areas and lower marsh areas. It is characterized by silty organic substrates and the presence of numerous large tidal pools. The dominant plant species within this floristically diverse habitat type are red fescue and meadow barley in lower areas and dune wild rye grass in slightly higher areas. Other species usually occurring in this habitat are yarrow, springbank clover, and Pacific silverweed. The total percent vegetative cover averages 90%. High marshes provide spring forage for American black bear and important year round forage for Roosevelt elk and Columbia black-tailed deer. Waterfowl use of high marshes is limited to grazing by dabbling ducks, Canada geese and trumpeter swans. Other wildlife which utilize this habitat type include songbirds, small mammals, reptiles and amphibians. These areas are of less direct importance to salmonid rearing than lower marshes, however they are a major producer of detritus and source of nutrients for the estuary and adjacent marine areas.	12.9	8.8
Imi	Occurring on organic silt substrates, this habitat type is less diverse than the adjacent high marsh. The dominant plant species are Arctic rush and sea-side arrow-grass. Pacific silverweed, Lyngbye's sedge and sea-milk wort are also commonly present. Total percent cover ranges from 40-90%, averaging 65%. Wildlife use of this habitat type is similar to that of the adjacent high marshes. As well as being a major producer of detritus and source of nutrients, these areas and the tidal channels within them serve as important rearing areas for salmonid species when flooded.	4.1	2.8
Iml	This habitat type is located adjacent to intertidal flats and bars and is drained by numerous tidal channels. The predominately silty sand substrates are colonized by two plant communities. A Lyngbye's sedge dominated community occurs along tidal channels at low elevations and a community dominated by tufted hair grass occupies slightly higher elevations away from the tidal channels. Vegetative cover averages 50%. These areas are important for salmonid rearing. Bird use includes feeding by wading birds, migrating dabblers and Canada geese and wintering trumpeter swans. Diving birds may feed in these areas at high tide stages. Utilization by small mammals, reptiles and amphibians is low.	10.4	7.2
Ipl	This habitat type occurs within the marine portion of the study area and is characterized by bedrock substrates overlain by sand and large pebbles. Such areas are formed by erosional wave action. Wildlife use of these habitats is similar to beach face habitats.	0.4	0.3
	BACKSHORE ZONE	15.3	10.6
Bfo	Both coniferous and deciduous forests are found within the study area. Coniferous areas are dominated by Sitka spruce often associated with western hemlock. Salmonberry, red huckleberry and stink currant are common understory components. Deciduous forests have developed on recently deposited alluvium and are dominated by red alder. Forest habitats are utilized extensively year round by Columbia black-tailed deer and Roosevelt elk for cover and foraging. American black bear also forage within this habitat type and use by small mammals is extensive. Bird use includes nesting by cavity dwellers, passerines and raptors.	15.3	10.6
	Total area of entire study area.	145.0	100

6. Anthropogenic On Site Symbols



7. Sources of Further Information

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Hunter, R.A., L.E. Jones, and M.M. Wayne. 1982. Estuarine habitat mapping and classification system manual. APD Tech. Paper (in prep). B.C. Ministry of Environment, Victoria, B.C..

Marshall, D.E., M.J. Comfort, and E.W. Bretton. 1980. Catalogue of Salmon Stream and Spawning Escapements Statistical Area 26. (Kyuquot Sound) Canadian Data Report, Fisheries and Aquatic Sciences No. 183. p. 83-84.

8. Credits

Supervised by R.A. Hunter

Mapped by M.M. Wayne, A. Campbell

Field work by A. Campbell, L.E. Jones

Date of field work, June 1981

Photography used BCC116:118-129; BCC285:167-165, 180-183

Map drafted by Cartography, Terrestrial Studies Branch, March 1982

Base map prepared by Cartography, Terrestrial Studies Branch

1982 Edition